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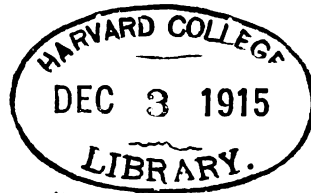
REPORT No. 5  
FOR  
**Manufacturing Orders**  
and  
**Schedules**



*Industrial organization, systematization and accounting  
by Clinton Edgar Woods*

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## Report No. 5

for

### Manufacturing Orders and Schedules

**T**HERE are two distinct Methods under which Units of Manufacture are put through a Factory: First, the Method which is known as Continuous Manufacture; second, the Method which is known as the Individual Order Method.

#### Continuous Manufacture

In this Method a concern obtains from its Sales Department an estimate of what they think they can sell for some given time period, usually a season's output. For instance, an Agricultural Implement Concern may estimate that it can sell One Hundred Thousand Mowing Machines, perhaps Fifty Thousand Harvesters and Seventy-five Thousand Rakes for some given year. This estimate will be duly approved by the Executive Committee and then passed to the Superintendent of the Plant in the shape of a Manufacturing Order.

Further, each one of these three items will be divided up into some given number of the various Sizes and Kinds of each that will be required.

When the Superintendent of the Plant receives such a Manufacturing Order, he converts it into a Production Order and issues Schedules to the Factory in such a way as to show exactly what the Factory must produce each day, week or month of the year, in order to obtain this output.

The same applies to an Automobile Business. For instance, it is estimated by the Sales Department that they can sell One Thousand Automobiles during the year. This thousand is then divided into the various Models and Sizes required. So far, this is only a Manufacturing Order subject to Schedules, as per the Factory capacity by Departments. The Schedules, however, are to be accompanied by Production Orders as they are issued to the various Departments from time to time.

#### Individual

#### Order Method

There are other lines of Manufacture, however, where Manufacturing Orders cannot be issued to cover a season's or a year's business. For instance, in the Manufacture of Boring Mills, batches of the various machines will be put through the Works from time to time, say in lots of twenty-five, and these batches constitute a Production Order. For example: From an analysis of Sales made in some given time period, together with the number of any given size of machine on hand, it will be deemed desirable to manufacture up a certain quantity, say twenty-five thirty-six inch Boring Mills. A Production Order will be made out in proper form and handed to the Engineering Department, at which point all of the various information will be furnished to the Factory as described in Report No. 4. Again, there may be, in such a business, certain sizes of Mills such as a 72 inch or 100 inch Mill which are only made to order. When the work for such a Mill is put in the Factory, it is covered by an Individual Production Order sent to the Engineering Department and treated as per Report No. 4.

This latter Method is the one that prevails in nearly all lines of manufacture making Machine Tools, Engines, Electrical Machinery, etc., so

that the principles employed for systematizing the one line of business can very readily be adapted to any of the other lines.

We have created a Store System as per Report No. 3, in such a way as to give a Perpetual Inventory on all Materials and Supplies of any nature whatsoever that a Company may buy, and as pointed out in Report No. 3, this Inventory is held in the Controlling Accounts of the Company; consequently, in order to authorize the delivery of Material to the Factory, and in order to have something to which that Material may be charged for Costing purposes, it is absolutely necessary to have a Heading of some kind to which not only all Material, but all Labor and Expense may be charged. Therefore, before any Goods can be released from Stores or before Labor can be employed for processing the Material, provision must be made to have something to which they can be charged, and this must of necessity be an Order of some kind, and these Orders must be known and controlled altogether by consecutive numbers.

To cover *all* of the Labor, Material and Expense used in the operations of a Factory, we have four different propositions before us which must be covered by four different kinds of Orders, the first of which is:

**Production Orders**      Production Orders relate exclusively to Goods made for sale, and which are wholly productive in their characteristics. These Orders are issued to cover all items which are to be manufactured for sale, each Production Order being made to govern whatever Quantity, Kind or Size of Unit, Piece or Part it is desired to make at any particular time; and all Material drawn from Stores and the Labor used for processing same must be charged to these Production Orders



as direct Costs, in addition to which a pro-rated amount of General Overhead must also be charged. (See Report No. 7 on Distribution.)

**2. Betterment Orders**      Betterment Orders relate wholly to Plant Improvements of any kind whatsoever that form assets for the Company to record on its books and which are wholly productive in their characteristics. Whenever a Foreman or anyone else in connection with the Plant desires to have any work done which would constitute a Plant Betterment, a Betterment Order should be issued to cover such work. No work of this character should be done until authorized by the Superintendent, who in turn must get authority from his Management for any Betterments costing over One Hundred Dollars. Instructions on this point to the various Foremen should be very explicit. To such Betterment Orders as are issued will be charged all of the Material drawn from Stores and all of the Labor used as direct Labor; and in addition to this, a pro-rated amount of General Overhead; that is, the same percentage as is applied to straight Production Orders.

**3. Repair Orders**      Repair Orders are certain Orders issued for the replacement, repair, etc., of Buildings and Equipment. Repair Orders are designed to take care of all Repair Work as done for or by various Departments, and to each Individual Repair Order will be charged all of the Material drawn from Stores and all of the Labor employed; but the Repair

Order does not bear any portion of General Overhead charge, as Repairs in themselves constitute a portion of such charges, which are in turn distributed to Production Orders and Betterment Orders.

**4. Standing Orders** In every Factory there are certain Materials and Labor used which are not put into any one of the foregoing Orders; as for instance, Oil, Waste, etc., used for operating the Plant, and Labor such as Foremen, Truckmen, Packers, etc., that do not enter into any of the above Orders. Consequently, there must be provided some means of distributing such items, either by having Standing Order Numbers or Distribution Account Numbers to which they can be charged, and then credited as they are pro-rated to Production and Betterment Orders, all of which is fully described in detail in Report No. 7.

The reason for this last Method is that for such Material and Labor as are used in this way and then charged to such Standing Accounts, no kind of an Order is issued, as the work may be done from day to day.

The Workmen's Time Tickets and Requisitions for Material in themselves show when Material or Labor is to be charged to Standing Accounts, as per whatever system of distribution is in vogue.

**Order** For this business, I recommend and have designed the Individual Order Method for issuing Orders to the Factory, and  
**Forms** have provided therefor three sets of separate forms, each bearing a caption, as per the above, and each form being made out in quadruplicate.

Form No. 40 is a standard Form of Production Order, the filling out of which is self-explanatory, as per the arrangement of the various captions on the Form. This form does not carry with it any shipping instructions, being, as its name implies, an Order on the Factory to manufacture some given Pieces, Parts or Units.

In the making of a Production Order, different kinds of Units, or different kinds of Pieces or Parts should not be placed on the same Order.

Always use a different Order for each separate thing it is desired to manufacture, for it is apparent that if we issue one Production Order having on it, for instance, the manufacture of twenty-five Valves and one Pump, or one Pump and Miscellaneous Parts. It would be impossible to use the Production Number as a thing against which charges could be made separately for the work done as called for by the Production Order. On the other hand, in the manufacture of Parts, as in the making of Bolts, for instance, any number of Bolts of different lengths but of the same diameter, could be issued on one Production Order, for the reason that the amount of Labor-Cost required for making same per hundred might be the same in each case, although the Material-Cost would vary. Each different diameter of Bolt, however, must have a different Order Number.

The responsibility for the issuing of this Production Order rests exclusively with the General Manager of the Company, who is the head of the manufacturing end of the business; but this work can be deputized by the General Manager to the Superintendent and Chief Engineer, who are his representatives in such work, to whatever extent may be necessary.

This production Order is to be made out for the Production of Pieces, or the assemble of Pieces into Parts, or the assemble of Parts into complete



Units to cover some Sales Order. It is always made out for a maximum and minimum amount of Material to be processed into Pieces or Parts, to cover the Store-keeper's blanket authority for having a certain amount of work done. (See Description of Maximum and Minimum Material Report No. 3.)

This Production Order is to be made out in four parts. The Green Sheet is sent to the Cost Department; the Blue Sheet is retained by the Chief Engineer; the Pink Sheet is delivered to the Store-keeper, who will, while the Chief Draftsman is preparing the necessary Bill of Material, Drawings, Specifications, etc., anticipate as much as possible the Material which will be required, and will, during this interim, inventory his Material to see how much he has on hand. The Yellow Sheet goes to the Superintendent, who will prepare to receive and process the Material.

The Pink Sheet held by the Store-keeper must remain in full force and effect until the completion of all goods specified on it and its Bill of Material. (See Bill of Material.) The Pink Sheet and the Bill of Material are then forwarded to the Cost Department, where they will be filed with the Bill of Material which has remained there in a file called "Unfilled Production Orders." Upon receipt of the Pink Sheet and the Bill of Material in the Cost Department, indicating that the Order is completed, it is put with the copy held by them and both are then placed in another file called "Completed Production Orders."

In addition to this it must be remembered, as described in Report No. 4, that the Superintendent also forwards to the Cost Department his copy of the Production Order together with all of the Department Orders which

have been issued to the various Foremen for executing the work called for by the Production Order.

In other words, all of the papers used throughout the Factory for Recording and Costing Production Orders have for their final destination the Cost Department, with one exception.

As soon as an Order is completed, the Production Order, the Bill of Material which it governs, and the Department Orders which are governed by the Bill of Material, must all ultimately come together in the Cost Department and then be filed in an appropriate way for future reference. Except the one copy held in the Drafting Department, these must all be filed numerically, and as each one of these shows the Bill of Material Number that it was made out from, we thus have a ready reference file for any look-ups.

Supplementary Orders      It may often happen that after a Production Order has been issued, additional work will be required which will call for a Supplementary Production Order. This also applies to Bills of Material.

When a Bill of Material is issued, stock should be cleared from Stores Account for this Bill of Material by entering the quantities in the column under "Reserved" on the Stores Card. If additional work on the Production Order from which the original Bill of Material was made out is required, a Supplementary Bill of Material must be issued for the additional work and handled exactly as though it were a new and different Bill of Material, but is marked as a "Supplement" to some previous Production Order. This naturally forces the Accountant to charge the original Production Order with this Supplemental Material.

"Supplementary Production Orders" and "Supplementary Bills of

Material" are the regular Production Order and Bill of Material Forms with the regular Production Order Number filled in and the Supplement Number also filled in, as provided for on the Form. When no Supplement Number appears, a regular Production Order is always indicated.

Should any Production Order call for a Bill of Material comprising more items than there are lines on one Bill of Material, each Sheet must be marked so as to show the total number of Sheets issued and the individual number of each Sheet. Thus, if there were three Bill of Material Sheets issued on one Production Order, the Bill of Material being No. 80, this number would appear on each Sheet as follows: 80-1-3, 80-2-3, 80-3-3, the first number after "80" indicating the Individual Sheet Number, and the second number "3" indicating the total number of Sheets issued.

The relation of Maximum and Minimum Amounts of Finished Stores to the issuing of Production Orders has a very important bearing in the handling of the Plant on the part of the Superintendent; for, as explained in previous Reports, the manufacture of Parts independently and the putting of them into Finished Stores gives the Superintendent an opportunity to obtain and maintain Maximum Plant Capacity.

When any item in Finished Stores is reduced to Minimum quantity, or nearly so, the Store-keeper has a right, if in his judgment necessary, to make out a Store Clerk's Order, Form No. 21, on the Superintendent to manufacture up that particular item to Maximum quantity. When the Superintendent receives this, it is to be converted into a Production Order just the same as a Manufacturing Order is, but not always necessarily independent of some Manufacturing Order. For instance, the Superintendent may have a Manufacturing Order to manufacture up twenty-five machines of a certain kind.



These machines would call for twenty-five Pieces of some certain form. The Maximum of these Pieces might be one hundred, and if the Stores were reduced down to twenty-five, the Superintendent would have to make out a Production Order for the seventy-five required for Finished Stores in addition to the twenty-five called for by the Manufacturing Order. In other words, the Superintendent can at any time issue a Production Order to manufacture any Piece called for by a Manufacturing Order plus any Maximum requirements on the part of the Store-keeper.

**Betterment Orders** In all manufacturing concerns there are more or less Shop Betterments made; that is, Betterments made by the Company itself, and as these Betterments form an asset of the Company, they are just as much productive work as are the goods made for sale; consequently the labor and material used for such work must be costed up in exactly the same way as are goods made for sale; but in order that there will be no possible mistake in making distributions to such work, a separate Order is provided (as per Form No. 41), which is, however, handled a little differently from the Production Order in issuing it to the Factory.\* In the first place, an Authorization must be secured for doing such work, which Authorization usually emanates from the Superintendent's office. (See Description of same.) The Betterment Orders are then made out and issued by the Chief Engineer:

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\*I have often been questioned as to why I consider Betterment Work productive, and I think it important that I should explain it for the benefit of my readers at this point.

Let us suppose, for instance, that it is necessary to obtain for the Plant a Special Machine of some kind and that it is optional with the management whether they will make it themselves or buy it. If they buy this Machine, it is duly put into General Stores, requisitioned out against some Betterment Order, and in due course charged up to Investment. On the other hand, if the Machine is made in the Plant it is costed out the same as any other item of manufacture and is bought by the Company on the one hand and sold to itself on the other. Let us say that the Machine in the market can be bought for \$1,000, but that for making it in the Plant itself \$200 in labor is spent and \$300 in Material. Many concerns in making Plant Betterments would use this as the Investment Figure. This is wholly wrong, for this figure should be increased by the same pro-rated amount of Overhead that is applied to the regular product made for sale, which let us say is 100 per cent. Therefore, the Cost of our Machine would be \$200 for Labor, plus \$200 for General Overhead, plus \$300 for Material, or \$700 in all, which at this figure

one copy of which he sends to the Cost Department; one copy he retains; one copy is sent to the Chief Store Clerk, and one copy goes to the Superintendent, exactly the same as the regular Production Order, and is handled and filed in the same way.

When work in the shape of Betterments is completed, it does not pass into Finished Stores as does the regular Product made for sale, but Work in Progress is credited, and Plant Betterments or Investments are charged. If there is a controlling account for Machinery and Equipment, another for Small Tools and still another for Real Estate and Buildings, one of these is charged with the work according to its character and is thus taken into account with Perpetual Inventory every thirty days, as provided for in the Chart of Accounts in Report No. 10.

**Repair Orders** Repair Orders are made out and handled in exactly the same way as Betterment Orders are. That is, an authorization is obtained to do Repair Work (except under certain conditions) and the Order for doing it is issued by the Superintendent; but as all work of this nature is a General Overhead Expense, the Material and Labor used are charged to the proper account as provided for in the System of Distributions in Report No. 7, and the total expense of this kind at the end of the month is, with the other expense of General Overhead, pro-rated over the Product made for sale and also Plant Betterments according to the amounts

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would be a net saving of \$300 over what the machine would have cost if purchased outside; but we eliminate any commercial profits in charging it up to Investment. In this instance, the Company could have sold this Machine for \$1,000 and made \$300, as it is fair to presume the outside concern would have done, but as there is no expense attached to making such a sale on the part of the Company to itself, I do not consider it good business to charge to the Investment Account such an additional amount, although I know of several concerns that do proceed on this line. The same general rule applies to all Betterments for Dies, Jigs, or Special Tools of any kind; but, as stated before in these Reports, the rate of depreciation at which these latter assets are written off will depend largely on their character and use.

for the month, except they are extensive repairs which must be pro-rated over a period of several months. To illustrate this: A Machine valued at, say, Three Thousand Dollars, gets into such a condition that it is necessary to give it a complete overhauling, the expense for which we will say is Five Hundred Dollars. Now, it is obvious that it would not be fair to charge all of this expense to one month's operations, as the benefits derived from such repairs will continue for a period of several months. Therefore, I recommend that in such cases a fair estimate be made of the time period which this should cover; that the whole amount be charged up to "Advanced Expenses" in the Controlling Accounts; and then written off on a basis of some given amount for each month.\*

There are many small repair throughout the plant that must be made from time to time without any delay and without the formality of waiting for a Repair Order to be made out. The Foremen of the plant should be instructed in this matter so that they may use their judgment, but under no circumstances should they be allowed to make such repairs without using Workmen's Time Tickets and Material Requisitions, the same as for anything else. After the work is done a formal Order can be made out and issued, and the number of the Order placed on these various Tickets so that the Accounting Department may properly handle them and have due authority for making the necessary distributions. This is a condition that must be very carefully watched, as Foremen are prone to do much small repair work while the men's time is charged up to the regular Product made

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\* Too careful consideration cannot be given to the above, as it must not be forgotten that aside from the direct value of Costs of Operation, their comparative value is of next importance, and unless distributions for such expenses as these are handled in an equitable way to the business, comparisons become valueless, as extraordinary expenses for any one month pro-rated over the Production made for that month will throw the Costs out so badly as to be useless for comparative purposes.



for Sale, and if this goes on to any great extent, it can very readily be seen how quickly Comparative Costs will be thrown out.

**Record of Production,**      In order to keep an Official Record of all Order  
**Betterment and**      Numbers issued to the Factory and the work which  
**Repair Orders**      they cover, I have designed a Record Sheet, as per  
Form No. 43, on which all Orders are to be entered  
as fast as authorized.

It is from this Sheet that the next succeeding Number is always obtained for Numbering any one of the three different Orders used; consequently, this Sheet will be kept in the Chief Engineer's Department and on it will be shown the following information:

1st—The date that the items were ordered.

2nd—The date on which they are to be finished.

3rd—Where the Order is for some Special Contract; the date on which it is to be shipped, and whether it is by Freight or Express; the date to be filled out under the corresponding column.

4th—The name of the article which is to be manufactured.

5th—The quantity which is to be manufactured.

6th—The Order Numbers.

In connection with these Order Numbers, no two Orders of any kind should ever bear the same Number, for if they do, it is very apt to lead to wrong charges in the Distribution Work of Costing. To make this impossible, I have provided three columns: One for Production

Orders, one for Betterment Orders and one for Repair Orders, which will be numbered as follows:

A Production Order is issued and it is given the Number "25"; another Production Order is issued and it is given the Number "26", both of which are placed in the column under Production Orders, one on each line. Next, a Betterment Order is issued and this will become Number "27" which will be placed in the column under Betterment Orders on the third line; then another Production Order is issued, which will be Number "28" and will be placed on the fourth line under Production Orders; then a Repair Order is issued which will be Number "29" and will be placed on the fifth line under the column of Repair Orders, and so on ad infinitum.

From this method of procedure it can very readily be seen that one Record Sheet will answer for the registration of all Numbers, and notwithstanding that there are three different kinds of Orders to be issued to the Factory, no two can ever possibly get the same Number. Especially is it so when we consider the fact that the numbers are all properly governed by Serial Order of arrangement and in one place.

7th—We have the Bill of Material Number corresponding to any one of the Orders issued, which of course, will come in consecutive order of arrangement, the same as the Order Numbers, and must be stamped on each Order Number

that it covers. This point must be remembered:

In many instances Repairs will have a Bill of Material issued the same as in anything else.

8th—We have the Unit Size or Model Number.

9th—The date on which it is to be finished.

10th—The place for registering the Purchase, and

11th—Name and Address on such Orders as are made on the “Contract” or “to Order” basis.

Authorization      One of the great propositions that confronts every Man-  
Requisition      agement is to get control of Expenditures for Betterments and Repairs. Usually this work is conceived and executed by the Superintendent and Foremen without any regard to the Management. They simply find out by their accounting that such expenditures have been made, but only after it is too late to prevent it. This does not refer so much to the purchase of new machinery as it does to the general improvements in a Factory which makes its own tools, some portion of its Equipment and Betterments to buildings. Especially is this so in connection with Shop Fittings and Fixtures which must form at least a temporary asset of the Company and sometimes a permanent one, but which expenditures are usually put into a General Expense Account. I say “temporary asset” of the Company because all Betterments of this nature are Assets and should not be written off to General Expense all at one time if we wish to get Comparative Costs.

Certain Lockers, Benches, Cupboards, Partitions, etc., are continuously being made in a Factory only too often without an authorization or accounting



thereof, the result of which is a marked change during certain weeks or months in Comparative Costs.\*

To guard against any expenditures of this nature being unduly made I have provided an Authorization Requisition for Betterments and Repairs, as per Form No. 44, and to meet the demands of such Requisitions I have arranged the Accounting so that certain appropriations will be made annually or semi-annually to provide for such work.

The Superintendent should be asked at the commencement of the year to make out an estimate as to the amount of money he will require for the ensuing twelve months for Repairs and Betterments, and the Executive Committee should then authorize a blanket appropriation to meet such expenditures; each different appropriation being given a number in the Accounting Department. The amounts as fast as expended should be shown on the Authorization Requisition in the spaces provided for same. These Requisitions are originally made up by the Superintendent, according as work of this nature is requested by the Foremen of the various Departments, or at his own suggestion, and in every instance must fill out on this form all of the information requested, so that the General Manager may know exactly what such moneys are being spent for.

The Superintendent will make out these Requisitions in quadruplicate and send three copies to the General Manager, keeping one in his own files.

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\* A certain concern in which I installed a Cost Accounting System only, ran the System for a few months and then called me in to analyze the results. Over 100 of the Cost Cards showed variations from 30 to 60 per cent. in Costs, and naturally the Management was ready to condemn the System, but it was the same old story; their business was only partially systematized. I analyzed some sixty cases which showed that while the men were working on some particular Production Order they had made Tools, fixed up Benches and various other things, the time for which had all been charged to Production Orders, and in doing this the Foremen seemed to be under the impression that they had been very wise in covering up such work. In one instance I found that over \$250 had been spent in this way in one Department during a period of 60 days, all of which resulted in convincing the Management that a partial system was worse than none at all, as they were not getting any Comparative Costs whatsoever.

Upon receipt of same the General Manager will forward these to the Chief Engineer with instructions to investigate the proposition and report on same. As soon as this has been approved by the Chief Engineer the three copies will be returned to the General Manager, who will sign same; send one copy back to the Superintendent; one copy to the Comptroller and keep one copy in his own files. As soon as the Superintendent receives this copy authorizing him to do the work he will make out either a Betterment or Repair Order according to the nature of the work to be done, after which the work will be handled as per the description of these two Orders.\*

As previously stated, the Superintendent can be authorized to make expenditures without using up this Requisition to some specified amount, say Fifty or One Hundred Dollars, which would usually cover all emergency cases, thus relieving him of the necessity of waiting for the formal proceedings necessary to the use of a Requisition; but as all amounts so used by him are taken from the appropriation just the same as those authorized, he will naturally exercise all the judgment possible in making such expenditures, so as to not exceed his estimated requirements.

**Scheduling**      A whole book could be written under this one caption, for  
**Production**      its importance to a Plant is of such a nature as to be absolutely the controlling factor between Plant Capacity and Earnings.

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\*The above may look like red tape to many concerns, especially to small ones, and, of course, such an arrangement can be modified to meet their requirements.

Last year a concern into which I introduced this system (which was vigorously protested when I introduced it), showed a net saving in charges to expense of over \$10,000 in one year, most of which would have been charged into Costs of Production instead of Betterments, according to the previous year's records. In addition to this, something like \$8,000 was saved on Repairs without in any way lessening the necessary Repairs to be done.

The moral effect of this method on the Superintendent, and consequently on the Foremen, is to make them take much better care of the Equipment in their charge, as they can readily understand that with a factor of this kind introduced into the Accounting, expenses of this nature are immediately going to show against them and there is no opportunity left for them to cover up carelessness or negligence by using Material and Labor on Production Order Time.

I have touched on this question three or four times, especially in Report No. 4, on Standardization and the obtaining of "Parts Common to All" Practice. I am now going to illustrate, not only the value of a Schedule, but the detailed requirements for installing and operating same.

The Scheduling of achievement of any kind presumes, to start with, a correct knowledge of possibilities. The speed of a train is scheduled by the possibility for such in the locomotive and the possibility of the locomotive is scheduled to weather conditions and roadbed, except in congested suburban service where the distance between stations also becomes a factor to which is coupled the possibility of acceleration on the part of the locomotive.

The Scheduling of a Factory presumes a definite knowledge concerning the Equipment in the various Departments, coupled with standard data covering the various Pieces and Parts that are to be made in each one of the different Departments, so that there will be such a uniformity of output in Pieces and Parts from each Department as will just maintain the Schedule of completed Units.

**Plant Capacity** In other words, the first consideration to be given this question is one of Plant Capacity and the balancing up of Labor and Equipment in the Departments, so as to get a full load factor for the investment made therein.

If a Factory uses fifty tons of Castings a day and their Foundry cupola is capable of producing only thirty tons, the balance, of course, must be obtained from outside sources, with a corresponding increase in Cost of Production due to the profits that must be made on the part of the concern from whom the Castings are bought. If the Machine Shop, on the other hand, is not capable of processing over thirty tons of Castings a day and the Foundry is capable of

producing fifty tons, the Foundry Work would be high in Cost compared with its Equipment Investment, unless outside work for the Foundry could be obtained. A reduction of thirty to forty per cent from the possible Output of a Foundry will increase Labor-Cost twenty to twenty-five per cent; hence the necessity of full-capacity output to maintain uniform Costs of Production on Castings.

Considering a Factory's own requirements without regard to Contracts for foreign items to manufacture, it is only as strong as its weakest Department, so far as economical Production is concerned. Consequently, what is required first is a balancing up of the Equipment and Labor in each Department so that they will all correspond in the volume of output required to make some given Schedule.

An all-important item in the balancing up of Departments is the securing of some Method for keeping record of Machine Tool Time.

As can be seen on the Workmen's Daily Time Ticket in Report No. 6, the hours which each piece of Equipment operates is given just the same as is the time of the man that operates it; for to obtain Maximum Equipment Output it is as necessary to watch the number of hours which each Machine operates weekly and monthly, as it is that of the man.

After all of the Labor is distributed, as per Distribution System in Report No. 7, Machine Tool Time is distributed each day on a sheet similar to Form No. 45. At the end of the month the total hours operated by each Machine is footed up, and we thus get a line on Equipment Efficiency and the use to which it is being put, for in a good live Plant idleness of Equipment is no more excusable than is idleness of men and with a proper Standardization of Pieces

and Parts and "Parts Common to All" Practice, work can be distributed to the various Machine Tools so as to keep them all busy most of the time.

This sheet is ruled for thirty-one days and on each side of each sheet can be registered the time for twelve different Tools. All that is necessary to do is to make up a book with a sufficient number of sheets to record all of the Tool Numbers in the Plant, and then to copy on this sheet each day the total number of hours shown on the Workmen's Time Tickets that each individual Machine has been operating.\*

I have pointed out several times the necessity of accurate information concerning Equipment and its arrangement in connection with possible output, but in reviewing what I have written I am afraid that I have not made this quite clear enough on one point.

It is common practice in many Plants to have the same kind of Equipment in different Departments. The result is that during a manufacturing season, some one or several operations are liable to be scattered over several

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\* The amount of idle Tool Time that will be discovered in almost any Plant by the use of this Sheet is past belief.

Time and again I have found the entire Equipment of a Plant idle 30 to 40 per cent. of the time that the Plant was in operation. This was based on an average of the total hours worked by all the Machines as compared to the total hours the Factory ran.

Under any circumstances, this is bad Factory Management, and yet in these same Plants I have heard Superintendents and Foremen complaining bitterly because the Management would not buy them additional Machine Tools.

It is not, under any circumstances, to be expected that every Machine Tool in a Plant will show full time, but at the greatest, the average loss should not exceed 10 or 15 per cent.

The real purpose for keeping this Machine Tool Time is to increase Plant Capacity, as if we can save 20 to 25 per cent. of the idle time of the Machine Tools it is equivalent to obtaining just that much more output without any additional investment; and yet I have seen Managers turn down this proposition because it costs from \$8 to \$10 a week to record the necessary information. This is one of the first things that I try to get into action in reorganizing a Plant, as from the information so gathered I get a line on Plant Capacity and, consequently, possibilities for Scheduling Output.

There is another purpose which this record of Machine Tool Time also serves. In arranging the Accounting System the basis for depreciating Equipment must be given consideration. Most concerns use a flat basis of 5 to 10 per cent. per annum for the depreciation to be written off on the various kinds of Equipment. Now, it is evident that some pieces of Equipment must be used a great deal more than other pieces are. A Lathe in the Tool Room, for instance, that is not used more than fifty-four hours in the month, will have a life actually four times longer than the same kind of a Lathe used in the Shop steadily every day during the month. Obviously, therefore, it is wrong to write off the same amount of depreciation for the two Tools.

Machinery is nothing more or less than a replacement of Labor for doing work, consequently



Departments. Consequently, there will be as many different kinds of Costs for the same piece as there were different Departments in which it was made, for the simple reason that no two Departments will have the same General Overhead Charges to pro-rate on the work, and the Character and Cost of the Labor is also apt to be quite different.

I have seen instances where these Overheads have changed from fifty to two hundred per cent. What this really means is, that we must get such a classification of the operations to be done as will enable us to group our Machinery in such a way that the same operations will always be done on the same Machines and in the same Departments. That is, our general practice should be, to give this point consideration in every way possible, otherwise we cannot obtain either uniformity in Costs or comparisons of same.

A careful study of this question will often necessitate not only a complete reorganization of the Factory Departments, but a very considerable re-arrangement of Equipment, and when such a rearrangement is necessary, geographical consideration of the Plant should be made along the lines pointed out in Report No. 1, illustrated by Chart No. 1. Further, it can readily be

a depreciation on Machinery should be charged into Cost of Production just the same as Labor is, and this depreciation should be in proportion to the amount of time any particular piece of Equipment is used.

If a Shop runs 54 hours a week, it will run 2,808 hours a year. If a Machine works steadily for this amount of time, we might write off 10 per cent. depreciation. However, supposing that our record shows that it has worked only fifty per cent. of this time, or 1,404 hours a year, we should then, in justice to this usage, write off but 5 per cent. depreciation.

Now, it is inevitable that in all Factories there are certain Tools which cannot be used steadily all the time, and this record of the time that they actually do work will form a basis for calculating the proper amounts of depreciation to write off.

By these means it can readily be seen that a Machine Tool will retire itself according to its usage without any regard to the calendar years' time of its service. In this way the exact age of the Tool for its use is always apparent by going over the records of the hours worked for any individual Tool.

A Tool may have been in a Factory ten years and yet be only six years old in actual service. Hence, the value of the Assets on the Company's Books will be quite different from what it would be otherwise by depreciation on such a basis.

This question of depreciation will be gone into very fully in a subsequent Report accompanied by elaborate tables showing depreciation values.

Provision is made on the accompanying Machine Tool Time Sheet to show the rate per hour for each Machine and the Earnings which should be charged up to depreciation each month.

seen that unless we have some such arrangement as this, the issuing of Production Orders and consequently Foremen's Orders, as made up with the Bill of Material, will be greatly confused.

Plant Capacity cannot be figured without taking into consideration the working hours per week. In Foundry practice, for instance, we must take into consideration the hours worked per week for the Capacity of the Foundry per day or per year for producing good Castings and the rating of Capacity must be the tonnage of Castings available for product; that is, good Castings, to which must be added the necessary percentages to cover loss due to poor Castings, Sprue, Scraps, etc. in order to determine the gross Cupola Capacity required, which is the total Melt necessary.

If the output of a Factory requires three hundred and thirty tons of good Castings per week, and our average percentage of good Castings is seventy-two per cent., the total Cupola Capacity for the week must be about four hundred and twenty-five tons, or about seventy tons a day, which would give us about fifty-five tons per day of good Castings.

Now, in figuring the total tonnage required in a Foundry, we have to use from our Standardization Work the kinds of Pieces that are required for our Production Orders; and the weight of each multiplied by the quantity required, will give us our total tonnage; information for all of which will come from our Parts Key Cards in the converting of the Production Orders into Foundry Requirements. The same applies to Blacksmith Shop Work, Wood Shop Work, and so on, for the various Departmental Material Requirements in such Departments as might be Originating Departments; that is, Departments doing the first Operation on Rough Material.

## **Schedules**

We now come to the all-important question of Scheduling Output for a Factory, and this means much more than a scheduling of the items of manufacture, for it also means the Scheduling of the amount of Labor required, of the amount of Materials to be used, and of the moneys that would be required for financing the work, all of which we will proceed to treat in the order above given.

In order to make this question perfectly clear, let us confine ourselves to an Individual Manufacturing Order, say for one thousand Machines to be made between October 1st, 1907 and September 30th, 1908.

Our first requirement then would be a Form upon which to register these Requirements, and for this I have provided Form No. 46, on which is first shown the number of the Schedule itself; second, the Manufacturing Order Number from which the Schedule is made up; then the Production Order Number or the Store Clerk's Order Number. First will be filled in, next to the Heading "Total Requirements", "One Thousand Machines"; then, next to the "On Hand" Heading, will be given the Inventory of such Machines as are on hand at the commencement of October 1st, which would be ninety-one, leaving a balance to be scheduled of nine hundred and nine.

Under "Time Periods", we show months and the date on which each week ends, together with the number of days in each week and the cumulative number of days for the entire period. Under the latter, we see that there are three hundred and three, and as we have nine hundred and nine Machines to make, we must make three Machines a day for that period. Therefore, under the Heading "Schedule" will be shown for each week the number of Machines that should be completed and ready for shipment that week, which for the first five weeks we see is eighteen Machines per week. On the week ending

October 9th, however, there are but five days in the week; therefore, the output for scheduling would be but fifteen Machines for that week, and so on for the balance of the year the schedule will show the number of Machines to be made each week.

As fast as the Machines are assembled and completed, the Follow-Up Ticket (as described in Report No. 3), used for assembling purposes, will be sent to the Order and Schedule Department and the total of these for the week will be entered up in the column under "Made." Under the Schedule column, we show the total number that was required up to any given date. For instance, up to the week ending October 9th, we should have had one hundred and five Machines made. If, however, there are only ninety-three Machines made, we will show under "Days" that we are two days behind our Schedule, inasmuch as we are twelve Machines behind Schedule. One of these schedules must be made out for every different Model of Machine that is made and by thus checking them, the Order and Schedule Department will always have facts available as to the condition of the work in the Factory.

Having made out our Schedule in the concrete, that is, for completed Units, we have the necessary data then for scheduling the Pieces and Parts required from the various Departments.

If we require three Machines a day, we will from our Bill of Material ascertain the exact number of Pieces required, and the Department in which the first operation is done, and from this we will make up Schedules for each Department accordingly. As fast as the work is completed in the Factory for different Pieces or Parts, the Follow-Up Ticket which accompanies the Material from the Stores is returned to Stores and is there immediately checked by the Storekeeper and then sent by him to the Cost Department where the

Order is checked as completed. The Follow-Up Ticket is then given to the Order and Schedule Department for checking up the Schedules.

The dating of these Schedules must, however, be in accordance with the time that it takes to get work through one Department to another. For instance, work would have to be scheduled for the Foundry some ten days in advance of the commencement of the Schedule in the Machine Shop, and the Schedules in the Machine Shop would have to be some thirty days in advance of those for the Assembling Room, data for which would always be available from both the Cost and Order and Schedule Departments.

In the above we have cited the scheduling of only one Manufacturing Order. Let us say now, that we have six Manufacturing Orders for as many different Models of Machines. Each Model would have a Schedule of its own as a completed Unit, but the Schedules for Pieces and Parts that are made in the Individual Departments would be consolidated in all cases where the Parts were the same for the six different Models of Machines.

Let us say that we want one Machine a day from each Model and that each Machine required a Casting which was identically the same. This would give us a Schedule of six of these Castings a day. If now, in addition to the Manufacturing Order, the maximum amount carried in Finished Stores is one hundred, and Stores were reduced to their minimum amount of twenty-five, we would have seventy-five Castings to make up, which would be pro-rated over the Schedule for the six Machines. Let us say that we wanted to re-cover into Finished Stores these seventy-five within thirty days, we would have to schedule three more a day, or our Schedule for that one particular Piece would be nine Castings per day for a month, after which, the rate would be only six a day.



This again illustrates very clearly the value of "Parts Common To All" Practice in Manufacture, by manufacturing on a "Pieces and Parts" basis, and doing all of the Costing Work in this way, rather than on a "Complete Unit" plan.

This is what is meant by the conversion of Manufacturing Orders into Production Orders, thus giving us an opportunity to obtain "Parts Common to All" Practice. In the above case, for instance, the Casting in question is a standard piece which is used on six different Machines and consequently is usable from a manufacturing point of view, without regard to which one of the six Machines has the greatest sale, providing that the number of Machines in the aggregate is up to expectations. Therefore, it is perfectly safe to manufacture up such a Piece in dull seasons and so give a Constant Load Factor to the Factory, and at the same time give it an opportunity to manufacture in quantities sufficiently large to obtain low Costs of Production.

Now comes the question of Scheduling Labor: Let us say that the estimated Sales Requirements are such as to give us practically full Capacity of Output. If this output requires from the Foundry two hundred tons of Castings per week (which from the records available is the normal output of the Foundry), we find that the Labor required in this Foundry under such conditions is an average of three and one-tenths men per ton of good Castings per day. The Labor required therefore, would be the number of men multiplied by the daily tonnage of thirty-three tons, or about one hundred and two men would be the Labor Requirements of the Foundry. One hundred and two men multiplied by nine hours per day would be nine hundred and eighteen man hours per day, which at the average wage rate of the men employed in the Foundry of twenty-four cents per hour would equal two

hundred and thirty dollars and thirty-two cents as the daily Pay Roll; and this multiplied by our Schedule Calendar of three hundred and three days would be twenty-nine thousand, three hundred and eighty-six dollars and ninety-six cents as the money required for the Pay Roll for the year.

As described in Report No. 11, I make a Chart showing the weekly requirements for money in this way and then check the actual Pay Roll against it from week to week.

As soon as Costs for any Departments have been ascertained, the amount of Labor required for any Schedule can immediately be determined and an absolute check kept on the Factory as regards the use of Labor.

Further, as described in the System of Distribution, we have a check on this Labor as between Productive and Non-Productive Labor, and as between the various kinds of work done by the Labor, so that no matter what the variation is, from a pre-determination of Labor Requirements, we can independently put our fingers on, not only the Department, but the Foremen and men who are responsible for the variations.

The same that has been said of Labor applies to Material. Once the Schedules have been set, we obtain from our Parts Key Cards the exact quantities and kinds of Material that will be required, and such information, after being made up, is handed to the Purchasing Agent as a guide to him in not only the quantity of Material that will be purchased, but also the required times of delivery.

Once these Deliveries have been scheduled, their quantity plus the price, will give a Schedule to the Treasurer of the Company for financing purposes. The importance of this to concerns who are large borrowers of money cannot be over-estimated; neither can the value of this information to the Purchasing

Agent be over-estimated, as he not only has definite information as regards quantity, but also times of deliveries, for long periods in advance, and can often secure decided advantages in placing contracts by having such information on hand to work with.

The foregoing presumes that a sufficient amount of Labor will be provided to maintain a certain Schedule, but there are often conditions which want to be met in an inverse way. That is to say, we want to know how long it will take to get out a certain amount of Output with a certain amount of Labor. If we have the hours that are required or the Cost Price, we can very easily determine this. Let us say that the Labor value on the Schedule for some given Machine is twenty thousand dollars. Naturally the time that it will take to get this out depends altogether on the number of men that will be allotted to it; that is, this twenty thousand dollars would be divided by the average wage paid for any given number of men. If the average wage is two dollars per day, and we put forty men to work, our daily Labor value will be eighty dollars, which divided into twenty thousand dollars would be two hundred and fifty days, as a possible Schedule. By this means we can always determine how many men should be put to work on any given Schedule to get it out in a specified time.

In other words, this method of procedure puts into the hands of the Executive, means for pre-determining achievement; that is, the results which they will derive from the Factory by certain combinations of Labor, Equipment and Output; and as we also provide means for checking up these results from day to day, adjustments can be made from time to time either in the Schedule rates or the men employed, so as to maintain an even Factory Output with a corresponding uniformity in Costs.

One thing that should be given special consideration in connection with "Parts Common to All" Practice is "Special Features", especially such Features as are items that can be sold with some one or several different Units of Manufacture. Special Features are usually Attachments of some kind, the use of which is often optional and should, whenever possible, be made up under a separate Production Order from the regular Units, and Costed out and carried in Finished Stores for either Sales or Assembling purposes. Consequently, these should be governed by a separate Schedule.

The manufacture of Attachments and Special Features is not usually such however, as to require a continuous Schedule, thus, it might be determined that two hundred attachments of some certain kind were all that were required for one year's business, and they might be of such nature that they could all be put through the Plant in a period of Sixty days. Now, whether we will Schedule them all to be made in sixty days will depend altogether on whether we can devote sufficient Labor and Equipment to their manufacture continuously for that period of time, and if so, for what would this same Labor and Equipment be available the Other Ten Months of the year? If they can be manufactured in sixty days it is obvious we will be apt to get lower Costs of Production. On the other hand, it may be desirable to manufacture up such Attachments as "fill-in work" and so spread the total requirements over a period of several months, all depending upon available Equipment and Labor conditions.

One of the strong determining features in Scheduling many Pieces and Parts, is the quantities that must be made up in order to secure satisfactory Costs of Production as compared to the total requirements for any given season, and the time which it takes to get them out. For instance, in the

manufacture of Bolts, our total requirements for the season may not be over seven thousand; manufactured in this quantity, we find that our Costs of Production are greater than what the Bolts can be bought for. On the other hand, if we can manufacture fifteen thousand Bolts at a time, our Costs of Production are considerably less than what the Bolts can be purchased for, but this gives us a two years' supply, and our carrying charges may be greater than the savings effected, in which case it would be cheaper to buy such Bolts.\*

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\* There are hundreds of concerns to-day manufacturing many items similar to Bolts, Rivets, Screws, etc., at a very marked loss to themselves, sometimes knowingly and sometimes not, but invariably with the excuse that it keeps certain Labor and Equipment busy which would not otherwise be employed, and that as it absorbs a certain amount of Overhead from the rest of the Product, they think that they are coming out about even. The facts of the case are they have fooled themselves on their Costs of Production in both cases. They have illegitimately reduced Costs on Standard Goods, and at the same time are making certain items at a loss. This is bad administration, both on the part of the Management for allowing it, and on the part of the Superintendent for wishing it, and shows, to start with, that the Factory is not properly equipped; that the Labor is not properly employed and, in short, that there is no balancing factor as between Possibilities and Requirements.







**Sup. No.**

**Bill of Material No.---**

Authorization No. \_\_\_\_\_

To be completed not later than \_\_\_\_\_

[illegible]

**This Copy Must be Delivered at Once to Cost Department.**

**SUPERINTENDENT.**

**This Copy Must be Delivered at Once to Chief Engineer.**

**SUPERINTENDENT.**

**APPROVED:**

**This Copy Must be Delivered at Once to Chief Stores Clerk.**

**SUPERINTENDENT.**

**APPROVED:**

**This Copy Must be Delivered at Once to Superintendent.**

**SUPERINTENDENT.**



Repair Order No. \_\_\_\_\_

Date \_\_\_\_\_

Charge to \_\_\_\_\_

For Dept. No. \_\_\_\_\_

Done by Dept. No. \_\_\_\_\_

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APPROVED:

This Copy Must be Delivered at Once to Cost Department.

\_\_\_\_\_  
SUPERINTENDENT.

APPROVED:

This Copy Must be Delivered at Once to Chief Engineer.

\_\_\_\_\_  
SUPERINTENDENT.

APPROVED:

This Copy Must be Delivered at Once to Chief Stores Clerk.

\_\_\_\_\_  
SUPERINTENDENT.

APPROVED:

This Copy Must be Delivered at Once to Superintendent.

\_\_\_\_\_  
SUPERINTENDENT.









# Authorization Requisition

for

## Betterments and Repairs

SUPERINTENDENT'S OFFICE

APPROPRIATION STATEMENT

Appropriation No. \_\_\_\_\_ 190 \$ \_\_\_\_\_  
 Previously authorized - - - - - \$ \_\_\_\_\_  
 Called for herewith - - - - - \$ \_\_\_\_\_  
 Total - - - - - \$ \_\_\_\_\_  
 Balance - - - - - \$ \_\_\_\_\_  
 Date \_\_\_\_\_ 190

WORKS

To MR. \_\_\_\_\_  
 Dear Sir: GENERAL MANAGER.

*We would like authorization for the following:*

Name of Machine or Equipment \_\_\_\_\_  
 To be used in \_\_\_\_\_ Department,  
 in the manufacture of Part No. \_\_\_\_\_ of \_\_\_\_\_ Machine  
 Time required to deliver \_\_\_\_\_ days.  
 Estimated Cost including Installation \$ \_\_\_\_\_ Expected Saving per Year \$ \_\_\_\_\_  
 Remarks: \_\_\_\_\_

Yours truly,

SUPERINTENDENT

MR. \_\_\_\_\_  
 Dear Sir: CHIEF ENGINEER.

*Please consult, \_\_\_\_\_ and advise me  
 if you can improve upon this in any way and if in your judgment, it is desirable.*

Yours truly,

GENERAL MANAGER

To MR. \_\_\_\_\_  
 Dear Sir: GENERAL MANAGER.

*I have consulted \_\_\_\_\_ upon this  
 matter and \_\_\_\_\_ recommend same.*

Yours truly,

CHIEF ENGINEER.

MR. \_\_\_\_\_  
 Dear Sir: COMPTROLLER.

*Herewith find copy of Authorization of \_\_\_\_\_ 190, to make  
 improvements as noted.*

Yours truly,

Charge to Appropriation No. \_\_\_\_\_

GENERAL MANAGER.

MR. \_\_\_\_\_  
 Dear Sir: SUPERINTENDENT.

*This requisition is approved and the expenditure authorized with the attached amendments.*

Yours truly,

Authorization No. \_\_\_\_\_

GENERAL MANAGER.

Works Proposition No. \_\_\_\_\_



**SHEET No.**

DEP'T. No.

**MONTH OF**

# MACHINE TOOL TIME SHEET

[illegible]



**Manufacturing Schedule No.** \_\_\_\_\_

NO. FOR PRO. ORDERS \_\_\_\_\_

NO. FOR STORE CLERK'S ORDER \_\_\_\_\_

MFG. ORDER NO. \_\_\_\_\_

TOTAL REQUIREMENTS

FOR PRODUCTION ORDER NUMBERS \_\_\_\_\_

ON HAND

RATE PER \_\_\_\_\_

SCHEDULE BEGINS \_\_\_\_\_

BALANCE TO SCHEDULE

NO. DAYS RUN \_\_\_\_\_

SCHEDULE ENDS \_\_\_\_\_

TIME PERIODS				ITEM,--				REMARKS	
Week Ending		No. Days		Schedule		MADE		DAYS	
MONTH	DATE	In Week	Cum.	For Week	Cum. Total	For Week	Cum. Total	Ahead	Behind
October 1907	5	6	6						
	12	6	12						
	19	6	18						
	26	6	24						
November	2	6	30						
	9	5	35						
	16	6	41						
	23	6	47						
December	30	5	52						
	7	6	58						
	14	6	64						
	21	6	70						
1908 January	28	5	75						
	4	5	80						
	11	6	86						
	18	6	92						
February	25	6	98						
	1	6	104						
	8	6	110						
	15	5	115						
March	22	5	120						
	29	6	126						
	7	6	132						
	14	6	138						
April	21	6	144						
	28	6	150						
	4	6	156						
	11	6	162						
May	18	6	168						
	25	6	174						
	2	6	180						
	9	6	186						
June	16	6	192						
	23	6	198						
	30	5	203						
	6	6	209						
July	13	6	215						
	20	6	221						
	27	6	227						
	4	5	232						
August	11	6	238						
	18	6	244						
	25	6	250						
	1	6	256						
September	8	6	262						
	15	6	268						
	22	6	274						
	29	6	280						
	5	6	286						
	12	5	291						
	19	6	297						
	26	6	303						

This book should be returned to  
the Library on or before the last date  
stamped below.

A fine of five cents a day is incurred  
by retaining it beyond the specified  
time.

Please return promptly.







